Exponential functions

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Introduction

- $y = a_n x^n + a_{n-1} x^{n-1} + \cdots + a_1 x + a_0$

- $y = x^2$

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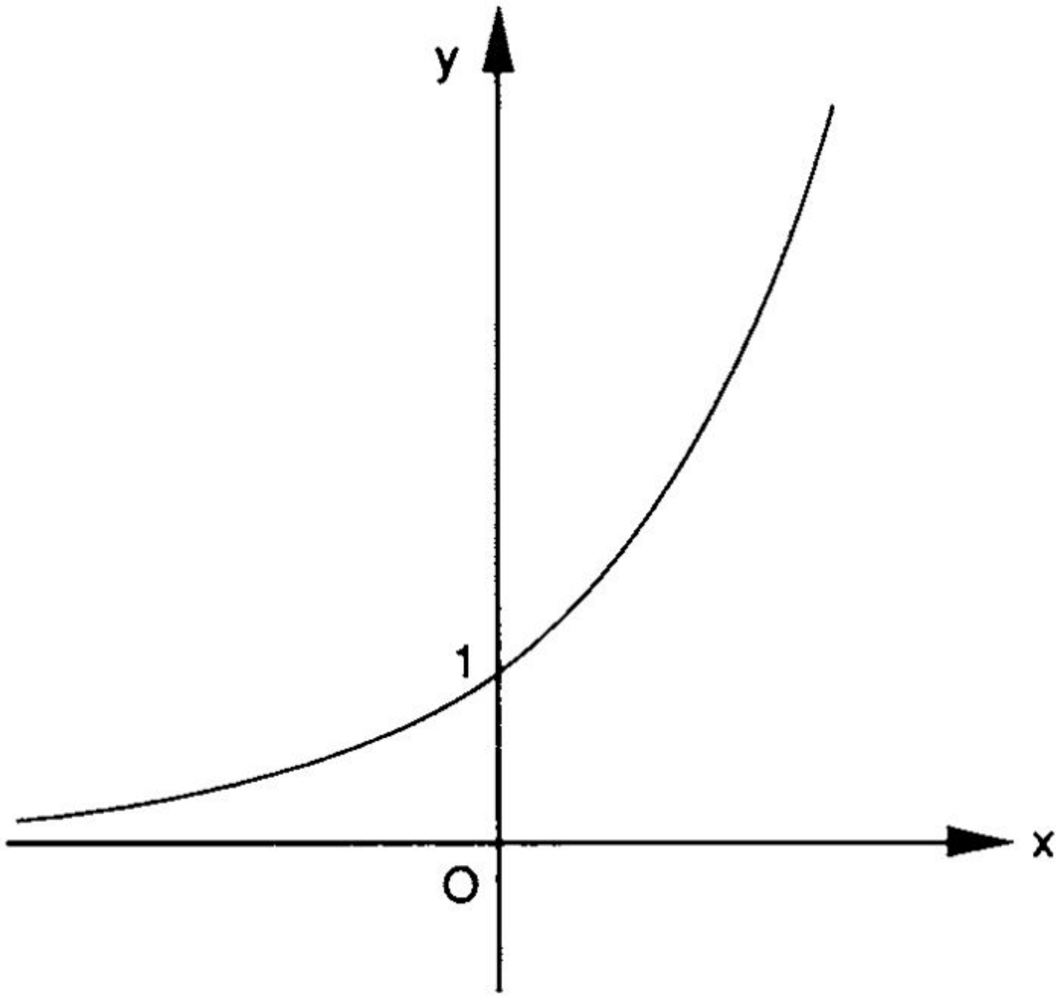
Introduction

- $y = x^2$ → $y = 2^x$ → $y = b^x$

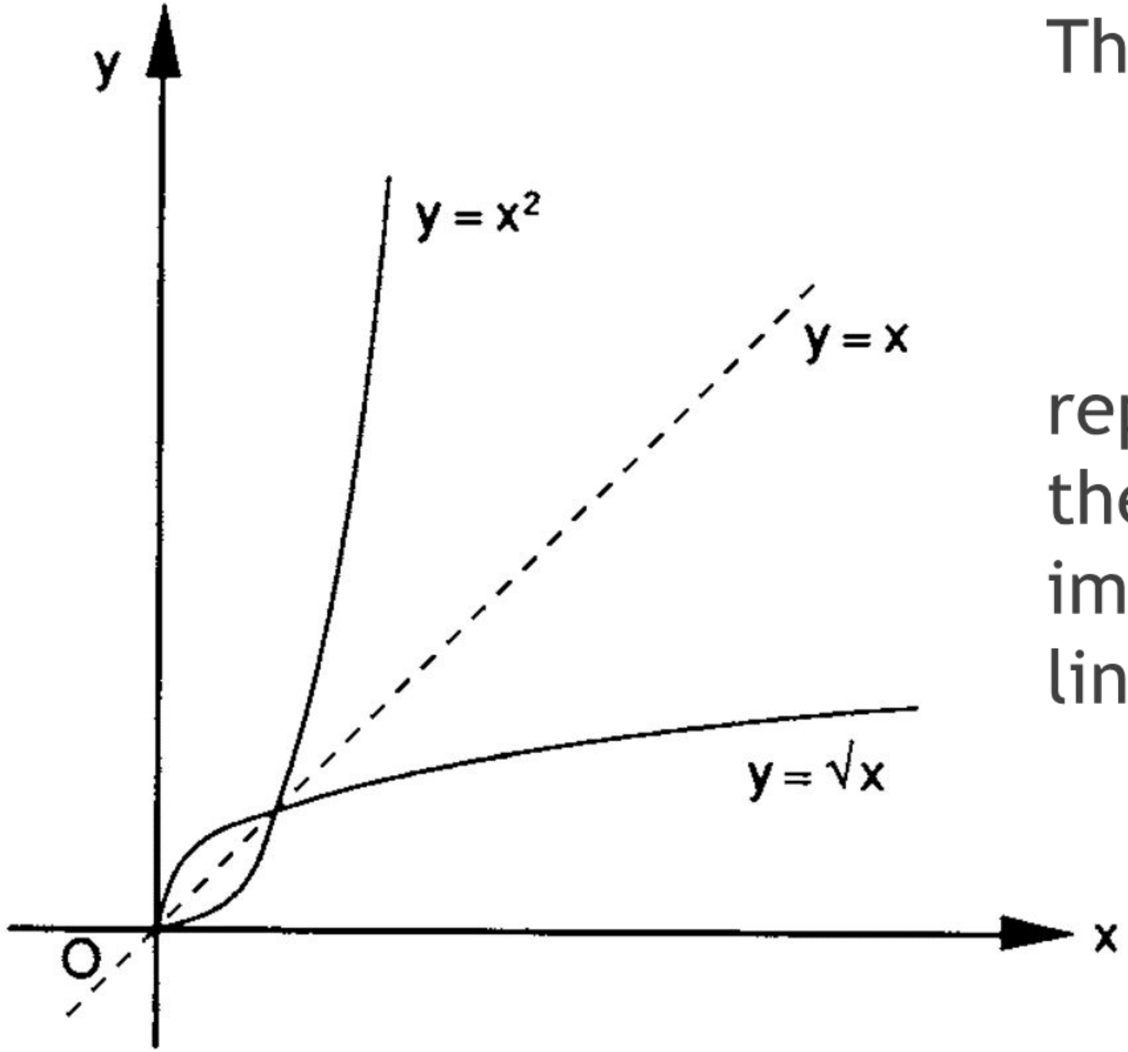
u^v was introduced by Leibniz in 1695

Graph of the exponential function



$$y = b^x$$

Inverse functions



The equations

$$y = x^2$$

and

$$y = \sqrt{x}$$

represent inverse functions; their graphs are mirror images of each other in the line $y = x$.

Inverse functions

$$y = b^x$$

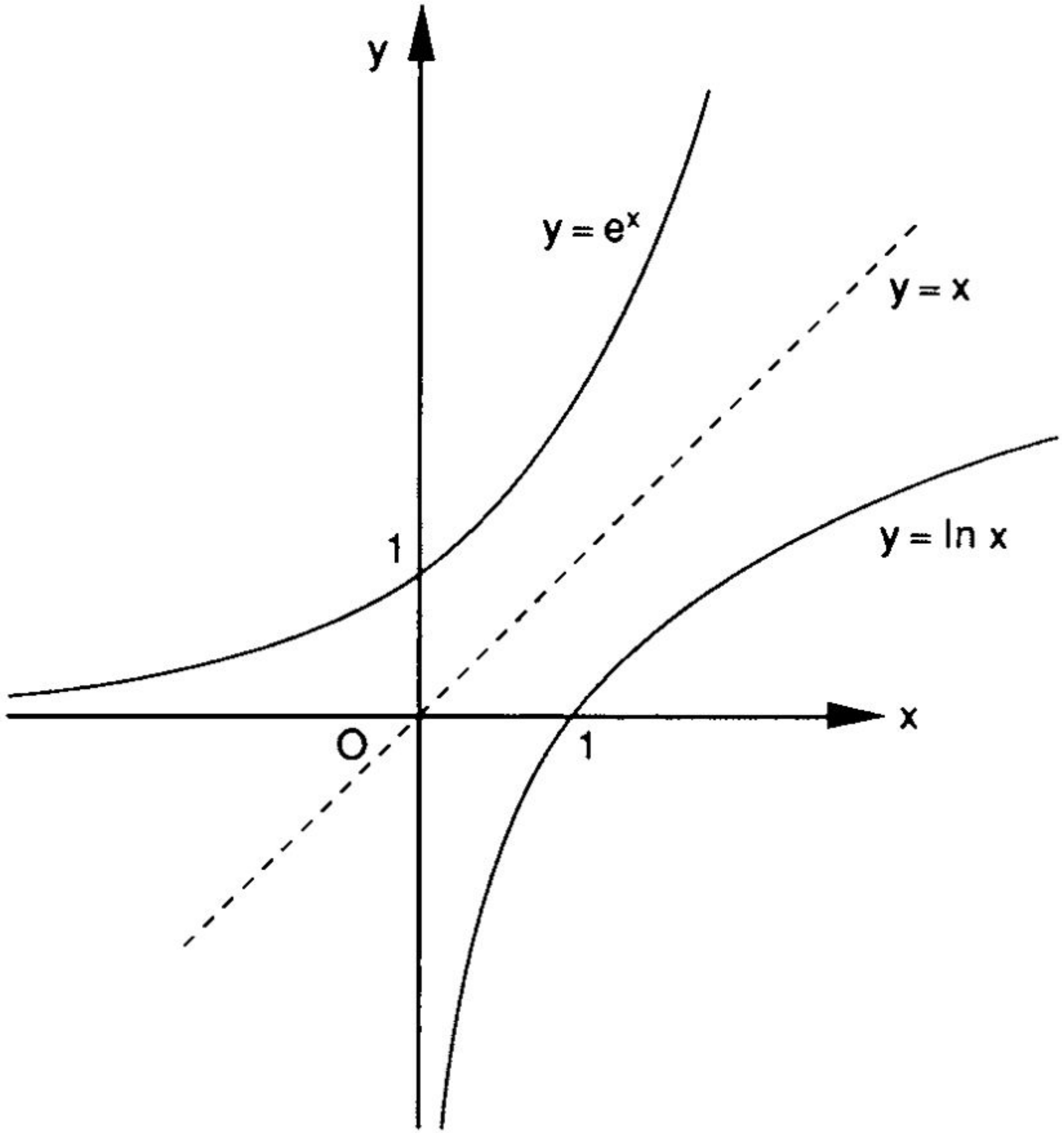
$$\Downarrow$$

$$x = \log_b y$$

$$y = \log_b x$$

(or $y = \ln x$ if $b = e$)

Inverse functions



The equations

$$y = e^x$$

and

$$y = \ln x$$

represent inverse functions.

Derivative of an exponential function

1. $\frac{dy}{dx} = \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x}, \ y = b^x$

2. $\Delta y = b^{x+\Delta x} - b^x = b^x b^{\Delta x} - b^x = b^x(b^{\Delta x} - 1)$

3. $\frac{dy}{dx} = \lim_{\Delta x \to 0} \frac{b^x(b^{\Delta x} - 1)}{\Delta x}$ ⇒ $\frac{dy}{dx} = b^x \lim_{\Delta x \to 0} \frac{(b^{\Delta x} - 1)}{\Delta x}$

If $k = \lim_{\Delta x \to 0} \frac{(b^{\Delta x} - 1)}{\Delta x}$, *then* $\frac{dy}{dx} = kb^x = ky$

The end

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